The Brain in Space

NASA SUMMER OF INNOVATION
UNIT
Life Science—The Body

GRADE LEVELS
7 – 9

CONNECTION TO CURRICULUM
Science and Mathematics

TEACHER PREPARATION TIME
2 hours

LESSON TIME NEEDED
4 hours *Complexity: Advanced*

DESCRIPTION
This lesson integrates a series of activities to investigate the effects of space travel on the human brain. Activities guide students to experience the challenges of spaceflight.

OBJECTIVES
Students will
- Model the inner ear and investigate the effects of motion on the inner ear
- Investigate the effects of motion on the human vestibular system and how that motion affects human actions
- Explore the effects of fatigue on human reaction time

NATIONAL STANDARDS

National Science Education Standards (NSTA)
Science as Inquiry
- Skills necessary to become independent inquirers about the natural world
- Understanding of scientific concepts
- An appreciation of “how we know” what we know in science
- Understanding of the nature of science
- Dispositions to use the skills, abilities, and attitudes associated with science

Life Science Standards
- Characteristics of organisms
- Organisms and environments
- Structure and function of living organisms
- Regulation and behavior
- Diversity and adaptations of organisms

History and Nature of Science Standards
Science as a human endeavor

Common Core State Standards for Mathematics (NCTM)
Measurement and Data
- Represent and interpret data

Geometry
- Draw and identify lines and angles and classify shapes by properties of their lines and angles

MANAGEMENT

The activities in this lesson should be done with cooperative groups of two to four students. For Visualizing How the Vestibular System Works, prepare the apparatus the day before conducting the activity with students. During the Vestibular—Ocular Reflex activity, be sure to set up the day before and monitor students for safety during the activity because they will probably experience dizziness. An option for the How Quick Are Your Reflexes is to do the activity early in the day and then repeat it once or twice between other activities to investigate the effects of fatigue.

CONTENT RESEARCH

These activities focus on the vestibular system and how the brain interprets the information from the vestibular system when combined with other information from systems such as the ocular reflex. In addition, the effects of fatigue on the brain and reflexes will be investigated.

Key Terms:

- **Vection:** Illusion that the body is moving in a circle (circular vection) or in a line (linear vection) when, in fact, external visual cues are moving relative to the body.
- **Vestibular system:** Helps to maintain balance and equilibrium.
- **Vestibular Ocular Reflexes:** To coordinate eye movement relative to head movement.
- **Disorientation:** To lose bearings.
- **Reflex:** Automatic and involuntary action.
- **Otolith organs:** Small granules in the inner ear

LESSON ACTIVITIES

The listed sequence leads students from investigating basic reflexes to investigating the effects of motion on the human body.

MATERIALS

- *Hot glue gun and glue sticks*
- *Lazy Susan or other rotating device*
- *False eyelashes*
- *Clear glass jar or cylinder with lid*
- *Water*
- *Watch*
- *Notepad*
- *Pen or pencil*
- *Book*
- *Blindfold*
- *Protractor*
- *Chalk*
- *Yarn or string (approx. 1 m)*
- *Push pin*
- *Meter sticks*
- *Scissors*
- *Measuring tape*
- *Graph paper*
- *Bell*
- *Calculator*

How Quick Are Your Reflexes?

Students will learn what reaction time is and how it is measured and investigate the effects of fatigue on reaction time.
http://www1.nasa.gov/audience/foreducators/topnav/materials/listbytype/The.Brain.in.Space.html
Pages 152–155

Visualizing How the Vestibular System Works

In this activity, students will learn about the effects of different types of motion on the hairs suspended in fluid in the inner ear. Students create a model that permits them to visualize the movement of fluid and bending of hairs in the inner ear in response to motion. It also demonstrates how the vestibular system maintains or restores equilibrium despite movement.
http://www1.nasa.gov/audience/foreducators/topnav/materials/listbytype/The.Brain.in.Space.html
Pages 77–84

Vestibular-Ocular Reflex

Students will perform various investigations to understand the vestibular-ocular reflex and learn about the importance of visual cues in maintaining balance.
http://www1.nasa.gov/audience/foreducators/topnav/materials/listbytype/The.Brain.in.Space.html
Pages 85–92

Find Your Way Around Without Visual or Sound Cues
In this activity, students will play a series of simple games to investigate navigation without visual and sound cues.
http://www1.nasa.gov/audience/foreducators/topnav/materials/listbytype/The.Brain.in.Space.html
Pages 99–104

ADDITIONAL RESOURCES
NASA Education Brief—The Effects of Spaceflight on the Human Vestibular System
http://weboflife.nasa.gov/pdf/vbrief.pdf

Brain in Space Educator Guide: The study of the ways in which the body's brain, spinal cord, and network of nerves control the activities of animals and humans is called neuroscience. This guide targets a high school audience and provides background material and activities related to NASA's Neurolab research.
http://www1.nasa.gov/audience/foreducators/topnav/materials/listbytype/The.Brain.in.Space.html

DISCUSSION QUESTIONS
Each NASA activity includes discussion questions in the provided Student Data components.
Additional Questions:

- What adaptations could astronauts use to keep oriented in space? *Answers will vary.*
- Explain how your reaction time data can be used to determine the best time to do homework or exercise. *Answers will vary.*

ASSESSMENT ACTIVITIES
Each activity includes a Student Data Sheet. Ask students to add entries to their Mission Journal from the Train Like an Astronaut lesson. These entries can be used as both formative and summative assessment.

ENRICHMENT
Instruct students to read the NASA Education Brief “The Effects of Spaceflight on the Human Vestibular System,” and discuss the adaptations that humans must make during spaceflight. Also, there are several additional activities in the Brain in Space educator guide. See additional resources for links.